JENSEN

Design of a Round House

Civil Engineering

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DESIGN

OF A

ROUND HOUSE

BY

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This is to certify that the thesis prepared under the immediate direction of Assistant Professor F. G. Frink by

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entitled DESIGN OF A ROUNDHOUSE

is approved by me as fulfilling this part of the requirements for the Degree of Bachelor of Science in Civil Engineering.

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Head of Department of Civil Engineering

D E S I G N OF A R O U N D H O U S E

-INTRODUCTION-

A committee composed of six prominent engineers and architects of various great railroads of the United States was asked by the American Railway Engineering and Maintenance of Way Association to prepare recommendations relative to the requirements of a modern roundhouse. The recommendations of this committee were printed in Bulletin No. 59 dated January, 1905, of the above Association. As the committee was unanimous in the recommendations presented, and as these opinions were voiced by men of wide experience, they may be supposed to represent the latest and best practice in roundhouse construction.

In the following pages the requirements of a modern roundhouse as outlined by the committee will be discussed in the order given. If different types of construction are in common use, a description of the different types will be given, and the relative advantages and disadvantages of each will be stated. In case the designs conflict with the ideas of the committee, reasons will be given why the designs as shown on the accompanying drawings were adopted.

The committee made the following report:

"REQUIREMENTS OF A MODERN ROUNDHOUSE

The committee recommends that a modern roundhouse be designed and equipped as follows:

C O N T E N T S

(1) That the form be circular and that the locomotives stand in the house normally, with the tender toward the turntable.

(2) That distance from center of turntable to the inner side of round house shall be determined by the number of stalls required in the full circle.

That length of stall along center line of track should be not less than 85 feet in the clear.

(3) That clear opening of entrance doors should be not less than 12 feet in width and 17 feet in height.

That the angle between adjacent tracks should be an even factor of 180°, so that the tracks at the opposite ends of the turntable will line up with it.

(4) The turntable should be not less than 75 feet in length.

The table should be operated by power, preferably electric.

(5) The material used in construction of the house should be non-corrosive, unless proper care can be taken to prevent corrosion.

(6) Engine pits should be not less than 60 feet in length, with convex floor and with drainage toward turntable. The walls and floors may be of concrete, and proper provision should be made in construction for the support of the jacking timbers.

(7) Roundhouse doors should roll or fold and be made of non-corrosive material, unless the cause of corrosion be removed.

(8) Smokejacks should be fixed, having large hoods; constructed preferably of non corrosive material and supplied with dampers. The cross-section of the stack should be not less than 30 inches in diameter.

(9) The floor should be of vitrified paving brick laid flat on a concrete foundation and grouted. It should be crowned between pits, and that part adjacent to pits within jacking limits should be of wood.

(10) Drop pits should be furnished for handling truck wheels, driving wheels, and tender wheels. These can be most economically constructed in pairs.

(11) The building should be heated with hot air by the indirect method, and the supply should be taken from the exterior of the building (no recirculation of air should be allowed.) The air should be delivered to the pits under the engine portion of the locomotive.

Air ducts should be located under the floor and special precaution should be taken to keep them dry.

(12) As much light should be obtained from the exterior of the building as good construction will allow.

(13) There should be an arc light, and a plug outlet for incandescent lights in each space between stalls.

(14) The contents of boilers should be taken care of and discharged outside of the building in a suitable receptacle, and the heat units used as may be deemed best.

(15) Cold water should be supplied at each alternate space between stalls from an outlet not less than 2-1/2 inches, located at a point about opposite front end of firebox; the water pressure should be not less than 80 pounds. The hydrants should be located below the floor in properly constructed pits amply drained.

Modern practice requires the use of hot water in the maintenance of boilers.

(16) Compressed air is used for mechanical hoisting and blowing operations. Overhead outlets should be furnished in each space between stalls opposite front end of firebox. The pressure should be from 80 to 100 pounds.

(17) A modern roundhouse should have facilities for the location of a few necessary machine tools, preferably electrically driven.

(18) Air hoists, or portable gooseneck cranes with differential blocks, on wheels, should be furnished for handling heavy repair parts.

(19) The turntable pit side walls should be concrete with wooden coping not less than 6 inches thick, and the ties under the circular rail should be supported on concrete walls. Pivot masonry may be of concrete with stone cap."

RECTANGULAR VERSUS CIRCULAR ENGINE HOUSES.

REQUIREMENT #1. The circular type of engine house is the most common type in the United States, but rectangular houses with transfer table have been used in France and England for a long time. It is only within recent years that the rectangular type has been introduced into America, the most notable instances being those built by the Pere Marquette Railway Co. at Grand Rapids, Mich., the Union Pacific Ry. at Cheyenne, Wyo., and the Terminal R.R. Ass'n of St. Louis.

Each type of house has its advantages and disadvantages. The points considered favorable to the rectangular type are as follows:

1 - Economy of ground used for building.

2 - Uniform room at front and rear of engines while in house, making it easier to work on engines in the house.

3 - Erecting, machine, and paint shops can be in connection with engine house, and either can be utilized as circumstances may require, thus concentrating building, men and tools.

4 - Easy enlargement of house, as end wall can easily be removed, and transfer pit easily extended.

5 - More open to inspection and more uniformly lighted.

6 - Ease of removal of engines in case of fire.

7 - An electric traveling crane could be installed if desired.

The advantages of the circular type are as follows:

1 - Close proximity to turn-table, making the dispatching of engines a matter of very little delay.

2 - Each engine accessible without disturbing the others.

3 - Saving the expense of transfer table and cost of operating.

4 - More room for doing work around locomotive where space is most needed.

5 - Artificial lighting more simple.

6 - Better light around the engine end of locomotive.

7 - Greater simplicity in piping designs for furnishing hot and cold water.

8 - Conveniences in control of work by a roundhouse foreman.

In either type some method must be provided for turning the engines as they enter or leave the house. In case a turntable is used the wear and tear on the turntable will be the same in both cases. In case a "Y" track is used in the rectangular type, the services of several men will be required to throw switches, etc., and the cost of switches and slip switches will be greater than the turntable of a circular house.

From a consideration of the above advantages of both types, and from the fact that rectangular design is not applicable to the majority of cases on account of the available space not being of the proper shape, it was decided that the design of the engine house should be circular.

LOCATION OF LOCOMOTIVE.

The locomotive should stand in the house with the tender toward the turntable as the work-benches are usually on the outer wall, and most of the repairs are on forward end of locomotive. There should be ample space in front of the locomotive for the removal of pilots, and enough room all around so that trucks and wheelbarrows will have plenty of space. As the center line of the smoke jack is 19 feet from the inner face of the outer wall it is believed that the space provided is ample.

LENGTH OF ROUNDHOUSE.

REQUIREMENT #2. In determining the dimensions of a roundhouse the following requirements must be met:

1 - The number of stalls required in the full circle must be even.

2 - The length of the turntable must be such that there will be no necessity for frogs at the rim of the turntable.

3 - The distance from edge of turntable to inner face of house must be such that it will be great enough for the largest engine.

4 - The distance from inner face of roundhouse to outer face must be great enough to easily accommodate the largest locomotive that ever will be placed in the house.

In this design the number of stalls in the full circle is 42.

The stall angle is therefore 8^{o} 34' 17".

The length of turntable used is 75 feet. As angle is 8^{o} 34' 17", the arc subtended at edge of turntable is 5" 7 1/4". Therefore distance between gage lines of adjacent rails is 5' 7 1/4" minus 4' 8 1/2" equals 10 3/4". Therefore no frog is required.

In case of fire or any emergency the track between the turntable and house could be utilized. As the largest locomotives of today are 65 feet long and the actual distance is 49' 3" it seems that the distance is not great enough for modern locomotives. But increasing this distance of 49' 3" would mean that the width of stall both at the front and the rear of the house would be greater than actually needed, thus involving greater expense. It is undesirable to increase the radius of the roundhouse because of the additional space required, and the slight advantage as given in the beginning of the paragraph is offset by increased cost of both site and house.

Distance from face of pilaster to face of post of roundhouse is 84 feet. As modern locomotives are about 65 feet in length, there will be about 18 feet in which workmen may work in front and back of engine. This is sufficient for all repair work, and for trucking.

CLEAR OPENING OF ENTRANCE DOORS.

REQUIREMENT #3. The number of stalls required in the full circle should be even in order that tracks can be laid out so that they will match the tracks on opposite side of the turntable. This saves shifting of the turntable, and is especially necessary when dead engines are to be moved.

Because of the fact that workmen are careless in fastening a door which has been opened, and because the doors are likely to be injured by a blow from a damaged cab, they should be of ample width. A clear opening of 12' 2" and a clear height of 17' 0" has been used, and satisfies the above requirement.

TURNTABLE

REQUIREMENT #4. The details of the turntable are not given in this design, but a 75-foot turntable is shown in plan. This is large enough to accommodate the largest locomotives which will probably be built. Either electric or gasoline power could be used as motive power. The larger turntables can not be operated by hand.

REQUIREMENT #5. The corroding action of the gases from a locomotive and of steam is very great in a round house so that the ordinary forms of steel construction can not be used. Even wood itself is slowly attacked and crumbles away.

WALLS

Although wood is used in the smallest houses for the walls, brick is by far the most common material. Any good, hard burned brick which is well bonded will do. Portland cement mortar is preferable to ordinary mortar.

Brick walls are better than masonry or concrete walls in case of a mishap such as an engine going through the wall, as a brick wall can easily be rebuilt.

ROOF TRUSSES

Light riveted steel construction in roof trusses is objectable because of the rapid corrosion. In some recorded instances such construction has literally fallen to pieces in a few years. If I beams are to be used, a thick section would be required, meaning a considerable cost. If steel is to be used it should be protected with concrete.

Wooden construction has an advantage of cost and life over anything perhaps except a concrete steel design. Reinforced concrete has been used in several cases, but has not been in existence long enough to judge as to its lasting qualities.

While no theoretical design of the roof trusses has been attempted, it is believed that the dimensions given correspond to the best practice. An objection might be raised in having the purlins running across the slope and thus acting as baffles to the smoke, but it is believed that most of the smoke will go through the smoke stack.

ROOFS

The requirements of a roof material are:

1 - It should be fireproof;

2 - It should be light;

3 - It should be non-corrosive;

4 - It should be durable.

The following materials have been used on roundhouse roofs: tin, corrugated iron, shingles, slate, "sparham", asphalt, and tar and gravel. Tin and corrugated iron have been tried and failed because of the rapid corrosion. Shingles and slate have failed

because of the rusting out of the nails used.

"Sparham" is made of a material found in Ontario and ground something like asbestos. This material is mixed with tar and the whole batch is put on boiling hot over a layer of double thick paper. It is very satisfactory for a flat roof but rather expensive.

In the asphalt roof a heavy coating of Trinidad asphalt is spread over a layer of four-ply asphalt paper.

But for most localities a tar and gravel roof is most satisfactory in the long run, and has been used in this design.

ENGINE PITS

REQUIREMENT #6. This requirement has been filled to the letter. The bottom of the pit is made convex so that a man working under an engine will be out of the water. The concrete should be made of one part Portland cement, two parts sand, and four parts stone. It is believed that the sections and plans fully explain the engine pit construction.

ENTRANCE DOORS

REQUIREMENT #7. Rolling steel doors have been tried in roundhouses, but have failed because of corrosion. Another objection to rolling doors is that in the winter time the moisture which is always present in a roundhouse condenses and freezes in the grooves of the door. This makes the doors hard to open and roundhouse men object to them.

A rolling wooden door would be free from the above objections, but on account of the high royalties demanded by patentees this door has not been generally adopted. It is neater looking than the swinging type, but is more liable to get out of order, and requires

a greater height of building at the interior wall than the swinging type.

The style of door adopted is shown on the design. Wrought iron hinges are used, and certain specified doors shall have small entrance doors for the convenience of workmen in entering and leaving the building.

The great advantage of the swinging door is the ease of repair in case of breakage.

SMOKEJACKS

REQUIREMENT #8. Various telescopic jacks have been designed, but the fixed jack is better. A telescopic jack is lowered over the smoke stack of the locomotive. A careless employe will forget to raise the smokejack when an engine is hurriedly ordered out, resulting in either a broken jack or a dismantled stack. Hence the requirement that the jack should be fixed.

In some instances hoods have been built ten or twelve feet longitudinally allowing the movement of an engine in that distance without affecting the jack. There is an added advantage in these long jacks in that the steam dome comes under the smoke jack, allowing the escape of steam directly up the jack.

The materials which have given satisfaction in smokejack construction are cast iron, tile, wood, and asbestos. Because of rapid corrosion any jack of thin rolled plate has a very short life, but cast iron 3/8" thick or more is not rapidly eaten away.

Vitrified stone ware and tile have been tried and given fairly good results. They are cumbersome, however, and liable to breakage.

At first thought it does not seem possible to build a smoke jack of wood. But by first painting the inside surface and then sanding it, a material is formed which becomes very hard, and is not affected by ordinary heat.

There is always some danger of fire in a wooden jack, and although the asbestos jack is more expensive it has been deemed advisable to use it. Such a jack is both light and fireproof, fulfilling the two essentials of a smoke jack, and has been used.

FLOORS

REQUIREMENT #9. Dirt floors are all too common in a roundhouse, and something better than this should be used, especially where boiler washing and the heavier machinery jobs are done.

Various causes combine to wear out a roundhouse floor, among which may be enumerated:

1 - Rolling of heavy trucks, and dragging back and forth of large pieces of machinery.

2 - Large quantities of water used in washing out boilers, much of which is spattered on the floor.

3 - Hydraulic jacks which bring great pressures to bear upon the floor adjacent to the cinder pits.

The materials used in modern floors are as follows, and are given in the ascending order of preference: cinders, cedar blocks, timber, planks, disintegrated granite,concrete and brick. Of these, cinders, planks, concrete, and brick are the most common, but each of the above materials will be discussed in the order given.

Cinders form a very cheap but a very poor floor. If the surface is kept moist and well compacted, and there is no washing of

boilers or heavy trucking, cinder floors serve fairly well. But as soon as the floor dries out, it will become dusty and gritty causing great annoyance to the workmen. By covering cinders with a few inches of crushed stone its wearing qualities can be improved.

Cedar blocks are a relic of the days when this was a favorite form of street pavements. If well laid they are neat, clean, and durable; but in case any heavy jacking is to be done great care must be taken lest the blocks be forced down through the planks of the foundation.

Timber block floors are similar to cedar blocks. The blocks are usually sawed rectangular, and obtained from old bridge timbers. Unless they are very well laid their surface soon becomes as rough as the street pavements of cedar block once so familiar in and about Chicago.

Unless the planks are of oak, such a floor deteriorates rapidly. An oak floor approaches that of a brick floor in cost.

Disintegrated granite is used by the Union Pacific Ry., but although a very good material, it is not generally available.

The great advantage of a concrete floor is that it presents a surface which can be easily washed and kept clean. If made thick enough it will withstand the effects of heavy jacking, and will not chip. But on account of the great expense, they have been built too thin in the past, with the result that they have cracked, and were not durable.

For most cases vitrified paving brick is most satisfactory and has been used in this design. Vitrified brick is hard, smooth, firm and practically indestructible. It is unaffected by water, heat, and grease, can be easily kept clean, and can be repaired without

difficulty,as any part can be taken out by ordinary labor and repaired.

In laying brick the foundation should be firmly compacted by rolling. A sand bed should be laid to grade. A concrete subgrade is desirable but expensive. The brick should be laid on edge, breaking joints, and cracks filled with Portland cement grout. It is better to lay the brick on edge, as there is then less tendency to rock.

DROP PITS

REQUIREMENT #10 - The drop pits used are shown in plan. The function of the drop pit is to provide for the removal of truck wheels, driving wheels, and tender wheels. The section is similar to that of the engine pits, and the material used is concrete.

Pneumatic hoists are usually provided for the removal of the wheels. Hydraulic hoists are better, as compressed air is so elastic that a pair of wheels on an air jack will spring up and down before finding its equilibrium.

HEATING AND VENTILATING

REQUIREMENT #11 - In the summer time there is no trouble with the heating and ventilating problem, as all the doors and windows are open most of the twenty-four hours, and the sun furnishes heat for long periods. But in winter time the conditions are not at all what they ought to be. There is a constant current of cold air coming in under the doors, in many roundhouses, and the heating facilities are very poor.

Coal stoves were used at first, but they gave off more smoke

than heat, and were not at all adequate for a large house.

A common way of heating in modern houses is by means of piping on the side walls of the engine pit. Live or exhaust steam is used. The men object to the presence of the hot pipes in the pit although pipes are very effective in heating the house. During the summer months the piping is often wrecked unless it is very strongly supported, and a new equipment is necessary in the autumn.

Heating by means of overhead air ducts has been tried. These ducts were made of galvanized iron, and the heat was brought wherever it was needed by means of small side ducts. The objection to this scheme is that galvanized iron corrodes rapidly, and the upper air was heated instead of the air near the floor.

The ideal heating and ventilating system is by means of the indirect system. Fresh air is brought in from the exterior of the building, and heated in steam coils. This hot blast is distributed around the building by means of a concrete duct, and delivered to the engine pits by means of vitrified tile pipe laid under ground. These ducts terminate in the sidewalls of the pit, and are provided with dampers at the pits. Such is the system used in this design.

By means of the hot blast the ventilating system is also solved, as it is not necessary to open doors or windows, but fresh air is delivered to the workmen, and the steam and smoke driven out through the ventilators. This hot blast is also most effective in thawing out engines which have come in covered with snow and ice.

Exhaust steam from air compressor, stationary engine and pumps can be utilized to furnish heat. There is an objection to this in that it may generate back pressure on the stationery engine, but this has not proven to be so.

It is believed that the heating system is shown fully in the plans. In this design the roof of the duct has been utilized as a trucking floor.

VENTILATORS

Some ventilators are aided in their action by outside air currents which draw out the foul air and gases, but most of them depend on natural draft. If possible ventilators should be so placed as to be over the steam dome, so as to dispose of the escaping steam.

The design shown is of wood and is the most common type; ventilators are only placed in every other stall.

NATURAL LIGHTING

REQUIREMENT #12. The conditions of lighting in some of the roundhouses which have been built are far from perfect. In some cases it is impossible to see the roof sheathing, and there is very little light in the center of the house even at mid-day.

The advantages due to good lighting are

1 - Better results from labor.

2 - Ease of inspection.

3 - Superior conditions of cleanliness and order.

Large windows have been provided in the rear of the house, and smaller ones in the front. The entrance doors are also provided with windows. The glass used should be of second quality, double thick, thoroughly bedded and back puttied.

As a further aid in lighting, generous application of white-wash is recommended.

ARTIFICIAL LIGHTING

REQUIREMENT #13. Because of the fact that roundhouses are used both day and night it is necessary to provide for lighting at night. For general illumination all over the house, arc lights are very satisfactory. Incandescent lights should be used where it is necessary to get down close to the work. It is thought that the money spent in electric lighting will be more than regained in the increased efficiency of the workmen. At their best, torches and candles are poor means of lighting.

Wiring plans are not shown in this design.

HOT WATER

REQUIREMENT #14. The hot water obtained from emptying the boiler, and from boiler washings, is discharged into a hot well where the scale and soft mud in the water settles to the bottom. The hot water in the well can be utilized either in refilling boilers, or in washing them, by pumping from the hot well back into the house.

WATER PIPES

REQUIREMENT #15. Cold water is used in washing out boilers. It is, however, considered better practice to use hot water in washing boilers, as it has been found that there is less trouble with leaky joints when hot water is used. Hot water is also used in filling boilers, as an engine can thereby be placed in service more rapidly.

Piping plans are not shown in this design.

COMPRESSED AIR

REQUIREMENT #16. Compressed air is used in the hoists, at the drop

pits, and wherever heavy lifting is required. Because of the increased weight of engines, parts which formerly could be handled by the machinist and his helper are now handled by the portable pneumatic hoists.

Another use of compressed air is in kindling the fires in the firebox by a forced draft. Engines are often required to be fired up rapidly so as to be placed in service as soon as possible, and compressed air aids in firing up.

Piping plans are not shown in this design.

MACHINE EQUIPMENT

REQUIREMENT #17. Extensive repairing is not required in a roundhouse, but there is often a call for light repairs which must be done quickly and accurately. The equipment should include two lathes of different sizes, a planer, a drill press, and a bench drill. The location of these machines and the engine to drive them is shown in plan.

AIR HOISTS

REQUIREMENT #18. Air hoists have been discussed under the headings, "Compressed Air", and "Drop Pits", which see.

TURNTABLE PIT

REQUIREMENT #19. The design of the turntable pit is without the scope of this thesis, and is only shown in a general way in plan.

CONCLUSION

It is believed that the design in general has satisfied the

requirements as outlined above. It is thought that the plans are full enough, and the main features of the design have been brought out in the preceding discussion, so that a detail description of the plans is unnecessary.

BIBLIOGRAPHY

The literature which the author has been able to obtain on roundhouse construction is as follows:--

1 - Roundhouse - I. C. Ry. of Canada, Railway Review of March 12, 1904.

2 - U. P. Ry. Shops, Engineering News, May 9, 1891.

3 - Comparison of Circular and Rectangular Engine Houses, Engineering News, March 3, 1904.

4 - Brick Floor, Eighth Annual Convention B. & B. Association.

5 - Smoke Jacks and Ventilators, Eighth Convention B. & B.Association

6 - Turn-Table Construction, Eighth Convention.

7 - Operating Turn-tables by Power, Eleventh Convention.

8 - Roundhouse Pits, Twelfth Convention.

9 - Roundhouse Doors, Fourteenth Convention.

10 -Buildings and Structures of American Railways by Walter G. Berg.

11 -New Square Engine Houses,Railway and Engineering Review, October 15, 1904.

12 -Comparison of Circular and Rectangular House, Pacific Coast Railway Club, Vol. #2, Bulletin #6.

13 -Requirements of a Modern Roundhouse, American Railway Engineering and Maintenance of Way Association, Jan. 1905.

14 -Discussion of the above Requirements, American Railway Engineering and Maintenance of Way Association, March, 1905.

15 -Railroad Repair Shop Design, Western Railway Club,April 21, 1903.

16 -Roundhouse Facilities, Central Railway Club, April 12, 1901.

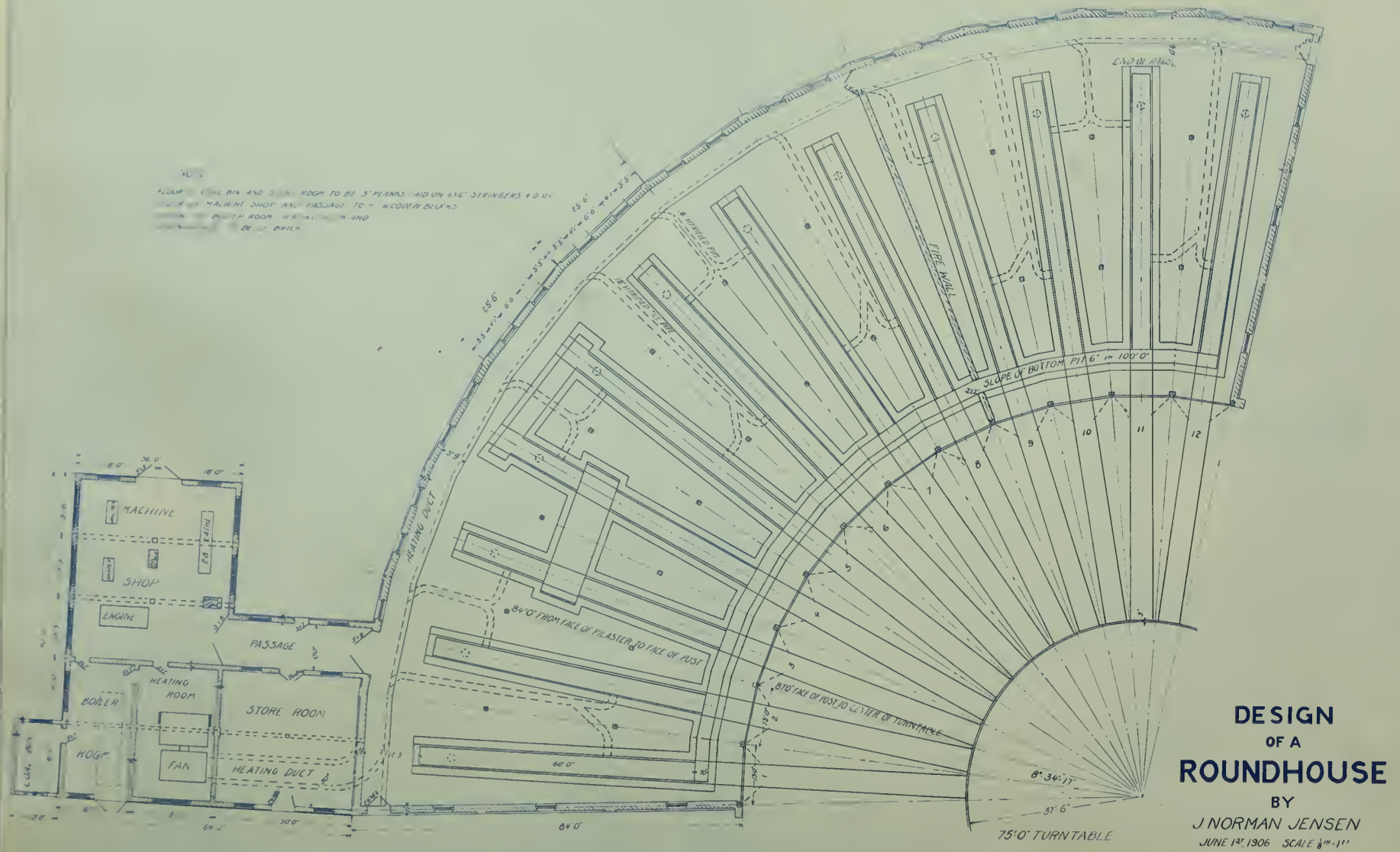
17 -Roundhouse Construction, Central Railway Club, Sept. 14, 1900.

18 -Square Roundhouses, Western Railway Club, Feb. 16, 1904.

19 -Modern Roundhouse Construction, New England Railroad Club, Nov. 15th, 1904.

20 -Transactions of the Amer. Soc. of Civ. Eng., Vol. 60, Dec. 1905.

21-Eng. News, Aug. 22, '01, page 120.



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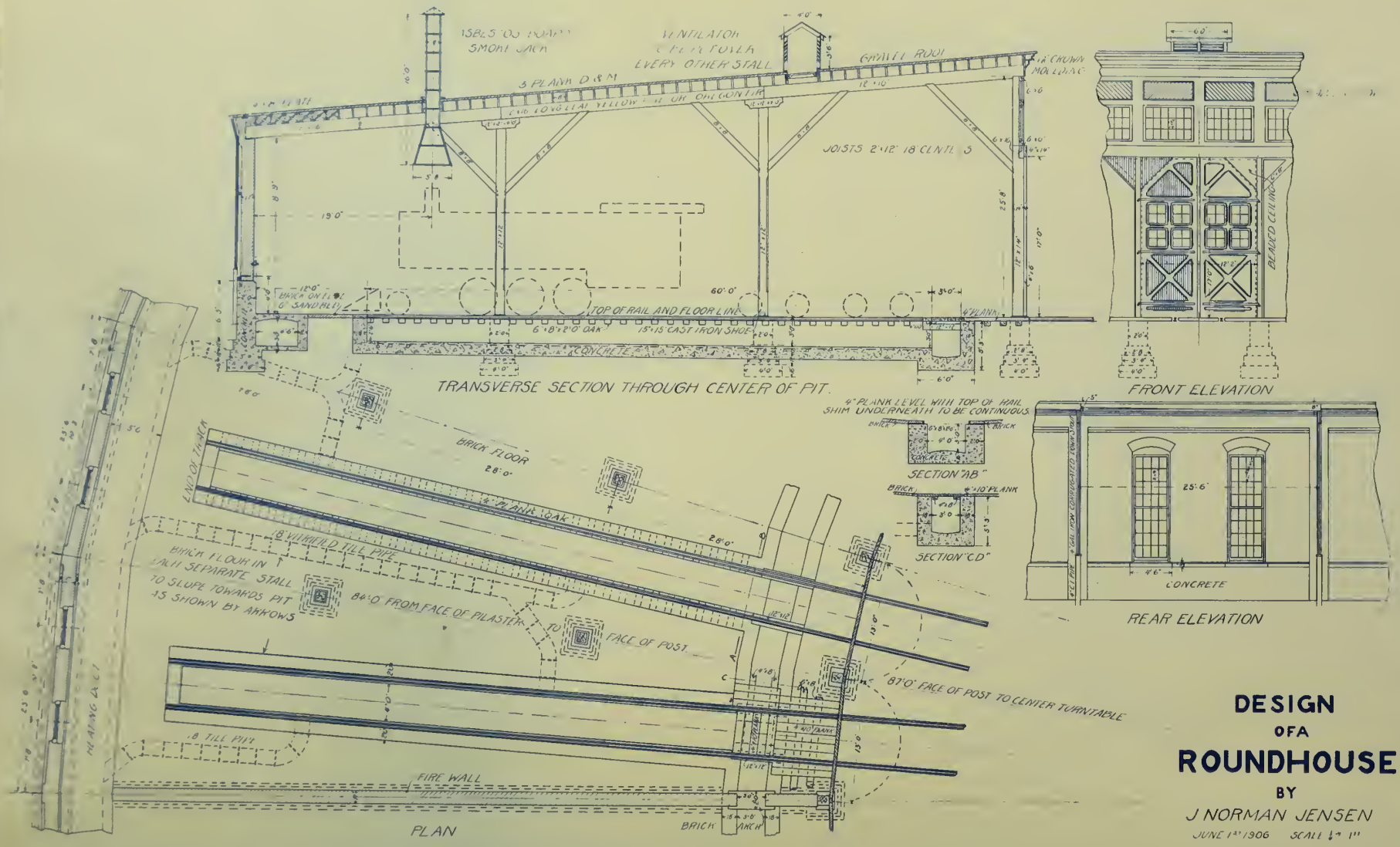
JUNE 1ST 1906 SCALE $\frac{1}{8}$" - 1'



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JUNE 1ST 1906 SCALE 1/8" = 1'